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14. ABSTRACT

Sea Basing is becoming vitally important to the future global projection of US military power. Sea Shield in its current form and as a vision relies on a network of sensors and shooters to protect the Sea Base and becomes a critical vulnerability. While Network Centric Warfare (NCW) and current platform defense systems are optimized against conventional threats, they do no suitably address the seams associated with asymmetric threats. While planners attempt to develop sufficient counters to every conceivable threat insufficient resources are devoted to increasing staying power-- the ability for a platform to physically withstand a hit. No system will ever be guaranteed 100% effective and the enemy, unable to match United States military force directly, will exploit the political effect of capitalizing on a single successful attack. Such an attack may cause a temporary disruption in offensive power projection (mission kill) and probably a longer period of degraded operation if the Sea Base were required to move in response to the threat until the seam could be identified and adequately countered. By building into the Sea Base and other power projection ships the ability to withstand a single "USS COLE" size attack risk of extensive damage can be mitigated and combat power for the Combatant Commander can be preserved even in the event of a successful enemy attack. Staying power adds a foundation of risk tolerance upon which other defensive systems can be built.

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NAVAL WAR COLLEGE
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BACK TO THE FUTURE:

STAYING POWER
AND
OPERATIONAL PROTECTION OF THE SEA BASE

By

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A paper submitted to the faculty of the Naval War College in partial satisfaction of the requirements of the Department of Joint Military Operations.

The contents of this paper reflect my own personal views and are not necessarily endorsed by the Naval War College or the Department of the Navy.

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ABSTRACT

Sea Basing is becoming vitally important to the future global projection of US military power. Sea Shield in its current form and as a vision relies on a network of sensors and shooters to protect the Sea Base and becomes a critical vulnerability. While Network Centric Warfare (NCW) and current platform defense systems are optimized against conventional threats, they do no suitably address the seams associated with asymmetric threats. While planners attempt to develop sufficient counters to every conceivable threat insufficient resources are devoted to increasing staying power-- the ability for a platform to physically withstand a hit. No system will ever be guaranteed 100% effective and the enemy, unable to match United States military force directly, will exploit the political effect of capitalizing on a single successful attack. Such an attack may cause a temporary disruption in offensive power projection (mission kill) and probably a longer period of degraded operation if the Sea Base were required to move in response to the threat until the seam could be identified and adequately countered. By building into the Sea Base and other power projection ships the ability to withstand a single "USS COLE" size attack risk of extensive damage can be mitigated and combat power for the Combatant Commander can be preserved even in the event of a successful enemy attack. Staying power adds a foundation of risk tolerance upon which other defensive systems can be built.

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INTRODUCTION

The realities of the 21st century – WMD proliferation and the politics of unreliable access to overseas bases — will require Joint Forces Commanders to increasingly rely on operating independently and securely from the Sea Base in order to continue executing National policy to protect vital United States interests in a global economy.[i] Operational maneuver and fires from the littoral is nothing new. Since the trireme, ships and navies have supported the combatant commander from the sea and in close proximity to land. What is revolutionary about the Sea Base is Force Net— the enabling technology which "binds together Sea Strike, Sea Shield, and Sea Basing."[ii] If, as the CNO says, "Force Net will…increase force survivability," then the seams associated with it must be strengthened.[iii]

The Sea Base moves the preponderance of in theater staging and logistics offshore in combination with naval force projection (Sea Strike). This allows forward presence and operations in international waters regardless of political atmosphere or shore infrastructure. It also alleviates the need to disembark personnel, equipment and supplies and set up a forward base. Combat power is moved directly from ship to objective. Most importantly it provides operational force protection by creating a moat between the mass of US forces and a potential enemy. This combat power concentration becomes one of the commander's strengths. Sea Shield protects this combat power. Force Net, embodied in Network Centric Warfare (NCW), enables Sea Shield and becomes the critical vulnerability to the Sea Base.

Sea Power 21, of which Sea Base and Force Net are fundamental components, is both a vision for the Navy's future and a new methodology for employing current forces as the Navy shapes its future. Today the Sea Base may be the Carrier or Expeditionary Strike Group. Tomorrow's Sea Base is still being conceptualized by Joint planners. Before the future Sea Base is built, whether they are ships or platforms, the basic requirement for

protecting them must be met. Each unit must have staying power—the ability to absorb combat damage—so that the seams in Force Net can not be exploited by an adversary.

EFFECTS BASED OPERATIONS VS. THE SEA BASE

It should be noted that the enemy's object is not necessarily to sink a vessel, but to render it combat ineffective. In a conventional war at sea scenario the attacker would doctrinally first attempt to neutralize a platform (i.e. no current offensive capability) and then return to finally sink the platform (deny enemy's future offensive capability).[iv] The threat today and in the foreseeable future will resort to asymmetric tactics not to sink or totally disable a vessel but to gain a political victory and to deny future access.

Sea Basing brings with it unique vulnerabilities: it adds a third dimension (undersea); an increase in Friendly (white) and neutral (grey) shipping and air traffic that make it a haven for the adversary; and international Law of the Sea greatly restricts ROE. Although NCW has enormous potential in protecting against large scale attack, its strength will force the enemy to attack asymmetrically. Any moderately successful attack has the potential to reduce combat power. The enemy will, as it has done in the past, exploit the political effect of capitalizing on a single successful attack to influence political will and popular opinion at home and abroad. Staying power fills the gap to limit any one successful attack into a minor incident.

The last U. S. ship sunk to hostile combat was the USS CARD (CVE 11) sunk while pier side in Vietnam by a mine in 1964.[v] In recent history there have been successful attacks which though they did not sink a ship achieved a political goal of the enemy. USS STARK was hit by an Exocet missile in 1987, the USS SAMUEL B. ROBERTS in 1988, USS TRIPOLI and USS PRINCETON in 1991 hit mines, and the USS COLE (Appendix Figure 6) was attacked by an IED via small boat in 2000.[vi] All of these attacks, the only ones in the

last 20 years, occurred in the same littoral AOR – CENTCOM. None of the attacks sank the vessels; however each one made the ship combat ineffective and had significant long term operational impact. Therefore, for the purpose of this paper any damage significant enough to sustain a mission kill is considered validation of a successful attack.

THESIS

While Sea Shield, Force Net and current platform defense systems are optimized against conventional large scale threats, they do no suitably address the seams associated with asymmetric attacks specifically those which will be prevalent in the littoral rich in civilian traffic. Regardless of the number and sophistication of defensive weapons systems, the single most determining factor in reducing the probability (risk) of a mission kill is staying power — the ability for a unit to absorb combat damage. The individual units of the Sea Base, what ever form they take, should have sufficient staying power to remain combat effective after a single successful "USS COLE" size attack.

To demonstrate the critical vulnerabilities, this paper will further define Network Centric Warfare as it applies to the Sea Shield and analyze potential vulnerabilities both in its current form and its near future capabilities. A short discussion will follow that shows NCW is not a panacea in the littoral where the Sea Base will be operating adjacent to neutral sea and air Lines of Communication (LOCs). By analyzing the various three dimensional threats to the sea base and current and conceptual defenses against them, it will demonstrate that the weaknesses of the current and near future Sea Shield and Force Net are:

- It is optimized against known weapon systems.
- It most often will not be able to engage asymmetric threats at max range negating the benefits of redundancy and reducing engagement decision time.
- Reduced decision time will require automatic threat identification inducing the increased probability for false targets and false negative (missed) targets.
- Additional defense systems regardless of effectiveness yield diminishing returns.

In order to preserve the Sea Base's combat power the gaps must be filled. The only logical conclusion that can be drawn is that staying power, holding inherent defense against all weapons regardless of delivery vehicle and independent of defense tactics, is the answer to reducing the total operational risk to the Sea Base. Despite this fact extraordinary sums are being spent on researching every conceivable weapon and attack scenario and developing counters (which only incrementally decrease risk with high monetary cost), while there has been relatively little research and change to hull design in 50 years which is the key to staying power.

PLATFORM VS. NETWORK CENTRIC WARFARE

The U.S. military is transforming from industrial age platform centric to information age network centric warfare. Platform centric warfare refers to an environment where the sensors required to detect, identify and engage the enemy are on the same platform (be it ship, tank or aircraft) on which the weapon is located. Although tactical links gave situational awareness on where to look, it was still incumbent on the shooter to correlate with his platform sensors in order to engage. NCW allows the senor and shooter to be geographically dispersed. "NCW generates increased combat power by networking sensors, decision makers, and shooters to achieve shared awareness, increased speed of command, higher tempo of operations, greater lethality, increased survivability, and a degree of self-synchronization."[vii] NWC is not a specific computer network or software program, it is the leveraging of information dominance to decrease decision time so that U.S. forces can act and maneuver decisively inside the decision loop of the enemy.

ENEMY AT THE GATES: LITTORAL WARFARE

Moving the Operating Base from land to sea has inherent operational protection value by creating a moat between the mass of US forces and a potential enemy. But it increases the

risk and opportunity for smaller asymmetric attack by operating in international waters. The same freedom of movement which makes the Sea Base attractive also allows potential enemies masked as innocent vessels to operate in close proximity. As the global standard bearer for the freedom of navigation, the United States cannot arbitrarily establish its own personal security exclusion zone in the same international waters it claims to have a right to operate independently.

There is some legal variation depending on where the Sea Base is located: Territorial Sea, Exclusive Economic Zone; High Seas, etc. Regardless of location, the "San Remo Manual on International Law Applicable to Armed Conflicts at Sea" applies. It recognizes the right of self defense and allows, as an "exceptional measure," the use of a zone; however, that does not absolve a belligerent of the duty to prove a vessel hostile. Furthermore:

- Due regard shall be given to the rights of neutral States to legitimate uses of the sea;
- Necessary safe passage through the zone for neutral vessels and aircraft shall be provided.[viii]

The manual also exempts "small fishing vessels and small boats engaged in local coastal trade" from attack.[ix] It is incumbent upon the commander to identify such vessels as hostile. The bottom line is that despite exclusion zones, neutral merchants and aircraft along with coastal craft are still free to roam the seas as long as there is no hostile intent or action (HI/HA). The Commander can expect to have numerous potential enemy combatants in close proximity to his operational base. Whereas, the land base can be a walled fortress with a large stand off distance from civilian traffic, the Sea Base quite the contrary can be a haven.

NCW advantages diminish as potential enemy vessels operate within the Sea Shield umbrella; initial detection may be at some distance short of maximum engagement range, even possibly at a minimum range. NCW promises to leverage information dominance, but

it is a near impossible task to maintain absolute situational dominance on every craft larger than a canoe within the Sea Shield construct. Sea Base protection relies on reliable intelligence of an attack and the port of origin of a potential threat. Unless HI/HA is observed, Force Protection forces must query and request individual vessels to stand clear.

This difficult, time and manpower intensive task was tragically demonstrated during a small boat attack at the oil terminals in Al Basra on 24 April 2004. In two separate attacks small boats, one a traditional dhow sailboat, attempted suicide attacks on a terminal and an Iraqi tanker. Two speedboats were engaged and destroyed by security forces, but the dhow exploded as U.S. force protection personnel attempted to board it.[x]

This operation yields two weaknesses pertinent to operational protection in the littoral. First, they were not unexpected since "intelligence reports had predicted for some time that such attacks could occur."[xi] Second, a versatile enemy will observe and test our tactics to find innovative ways to subvert them. Even though the attacks were unsuccessful and none of the vessels could have significantly damage their intended targets, the port was temporarily closed, inspiring an associated rise in oil prices a result of less confidence in the oil supply security. The political objective was attained despite being a tactical failure.

Littoral operations invite asymmetric attack inside the commander's decision loop. Although many legitimate merchant vessels may choose not to bother with force protection harassment in the Sea Base area, the Combatant Commander cannot deny access. The sea environment creates a different time/space/force relationship than land: our adversary can and will operate within our own detect to engage timeline.

ARGUMENT

Sea Basing and Sea Shields are both visions for future planning and a concept of operations for current force employment. The Sea Base may currently be composed of a

Carrier Strike Group, an Expeditionary Strike Group or any number maritime pre-positioned ships. Future Sea Bases could be pre-positioned logistic ships with at sea accessible cargo or platforms capable of conventional air operations and seaborne logistics.[xii] In any case the Sea Base will be composed of individual units which must be protected in three dimensions: undersea; surface and aerospace. Each unit will also have its own characteristics in terms of mobility, point defense and staying power. For the purpose of the analysis in this paper, it will be irrelevant how the Sea Base is composed in terms of what type of ship or craft. The analysis will assign arbitrary unclassified values for a generic vessel's attributes.

Likewise, Sea Shield is currently deployed in the form of the Cooperative Engagement Capability and in current naval doctrine for defense in depth at sea. The three dimensional effectiveness of the Sea Shield will vary with the particular forces available at any time, in what role they are assigned and their disposition. As a result the total effectiveness of Sea Shield will never be uniform over time or the entire area. As individual sensors and weapons reach maximum effective range, probability of kill (P_k) may decrease. Likewise the geometry of a ballistic missile results in a varying P_k for the interceptor along its path. There are complex computer models which will calculate these values; however this paper will assume there is homogeneous protection at a constant value within the entire sphere. It is imperative that the reader understand that this is not the case and that any system's effectiveness varies over space and time.

Size does matter when it comes to staying power. A large ship by virtue of its reserve buoyancy and total displacement may be able to withstand multiple hits, whereas a smaller vessel will obviously be severely damaged by the same size weapon. This relationship is not linear: twice as big does not necessarily mean twice as strong.[xiii]

ASYMMETRIC TREATS AND DEFENSES

"Terrorism experts are nearly unanimous …that is impossible to defend against every possible terrorist attack or potential scenario."[xiv] Terrorist know our weaknesses and they now have accurate data points for the Battle Damage Assessment (BDA) of their targets. Specifically, world news organizations published pictures of extensive damage to the USS COLE. It is beyond this paper's scope to catalogue every threat to the Sea Base. In fact one of this paper's arguments is that all threats cannot be known. The Sea Base's location will determine the threat. Closer to land will increase small boat threat, but may reduce submarine threat and vice versa. This section will attempt to give the reader an appreciation for the weapons which may be used asymmetrically.

Air Threats

The air threats to the Sea Base are: Anti-Ship Cruise Missile (ASCM), Theater Ballistic Missile (TBM) and Aircraft. The distributed network of sensors provided by Sea Shield is highly effective in detecting these threats at long ranges enabling weapons systems to engage at maximum range. This increases the probability of a successful engagement of air launched missiles by destroying a target before it can launch it weapons. It also allows greater reaction time if the first defensive salvo misses. The layered defense allows for point defense of individual platforms with various measures including, for example, electronic jamming or the Close In Weapons System (CIWS). The probability of success in these systems is lower due to the short range, ballistics and reaction time of fast moving targets.

Surface Threats

The primary surface threat to the Sea Base is by small boat attack. The ability for an enemy to carry out the attack varies with the Sea Base's distance to land. In close proximity it would be relatively easy especially when considering the deception possibility with

numerous civilian vessels. As the Sea Base gets further to sea it is a barrier to unsupported small boats and any small vessel would stand out like a sore thumb, if detected.

Besides the vast numbers of vessels in the littoral, their small size makes them difficult to detect under less than ideal circumstances. Although there are multi-spectral methods for detection, the effective range can be severely limited by environmental effects. A small boat can completely evade radar/IR detection in the trough of a wave. As nearly all radars now incorporate automatic processing and detection, the near random appearance of a radar return when the sweep happens to hit the boat on top of the swell can be processed out or lost in the high sea state clutter.

Airborne platforms such as helicopters are ideal for engaging small boat attacks, but are a limited resource-- there aren't enough to provide complete and continuous coverage and sufficient response time within the Sea Shield. As with air defense, once a target is detected, determining hostile intent will be the deciding factor to engage. Due to the risk of fratricide or collateral damage at close range, only platform point defense weapons may be available. The choice of weapons to counter a small boat is limited. Its small size and maneuverability requires precision and its close location to the sea limits weapon performance. Current weapons are not adequate and research must be devoted to a deployable area weapon which has the lethality to disable the boat without the need for precision. This type of weapon would be useful against a swarming tactic also. A conceptual directed energy weapon also shows promise providing precision dwell time sufficient to disable the target, rapid slewing for retargeting and a virtual unlimited magazine.

Subsurface Threats

Underwater threats to the Sea Base are from submarines (the shooter), torpedoes and mines. Mines pose an especially difficult problem because of they can range from moored

contact mines to smart mines which are underwater vehicles that can move and hunt for programmed prey. Detecting underwater threats is problematic because not only is water not transparent, but also the transmission capability of light and sound varies significantly with temperature, depth and even salinity. Unlike the air and water surface, the sea's terrain is as varied as on land providing numerous sanctuaries.

Networked sonar sensors can increase detection ranges, but passive systems are effective only against noisy targets and can be seriously degraded by background noise, notably shipping in the littoral. Note that the standard metric for detection probability in ASW is 50%. For Mine Warfare, Underwater Unmanned Vehicles (UUV) and an airborne laser are in development to increase the surveillance network; however, the key weakness in effectiveness is correlating detection into an actual threat. [xv]

ANALYSIS OF VULNERABILITIES

The Naval Postgraduate School (NPS) did an exhaustive modeling study to analyze the effects of force structure and network architecture on Sea Base protection using current systems and those plausible in 2015-2020.[xvi] The combat simulation had a target generator which inputted targets into various defense detection and engagement scenarios to gauge their relative effectiveness. They used eight different force architectures and six force mixes, running 100 simulations each. According to the study, "the submarines and torpedoes are by far the most significant threat. Torpedoes made up "roughly 10% of the total threat to the Sea Base ships, but account for over 95% of the mission kills."[xvii]

However, in the study all targets were considered hostile. There was no combat ID. Despite the lessons learned from Desert Storm, the U.S. military has not been able to solve what should be the easy half of combat ID, i.e. Positive ID as friendly, resulting in three fratricide incidents during OIF.[xviii] This problem will be systemic with NCW which will rely

heavily on automatic processing to quickly interpret raw data and network it to C^2 decision makers. According to the conclusion of a RAND study to determine measures of effectiveness for NCW:

> The assertion is generally made that a richly connected network of C4ISR facilities and weapon systems will improve decision making and therefore favorably impact combat operations. This may be true, but as yet we have no systematic universally accepted way to demonstrate the truth of this claim.[xix]

The principle weakness in any system which cannot be adequately modeled is target combat ID as friend or foe.

The greatest vulnerability, that the commander can least defend against in the littoral, is lack of deception. If the enemy cannot find the objective, it cannot be targeted. This used to be the greatest strength of sea power: the difficulty in locating an enemy fleet. Operations in the littoral where every fishing vessel or aircraft can gather intelligence on location and movements makes it nearly impossible to deceive the enemy as to force composition and location. Emission Control (EMCON) has become a relic and is impossible with NCW. Commercial satellite companies now offer world wide imagery with little time latency. By 2010 at least ten countries will have 1 meter or less resolution satellite systems.[xx] Freedom of navigation and low cost communications allow the enemy real time targeting.

As stated earlier, littoral operations allow the potential enemy to operate legally within our detection and engagement range. Constrained by our own ROE, decision time to engage a target is reduced. The target may negate the value of whole weapons systems by getting inside the system's minimum engagement range.

Successful protection plans rely on a layered defense. The total probability of success (P_S) increases as sum of the individual system P_S (Figure 3 in Appendix). However, there is a point of diminishing returns. **Figure 1** shows the total probability of success for an

increasing number of layered defenses each with $P_S = 0.5$ (50%). **Figure 2** shows the same system, only the effectiveness of the fourth layer is half (0.25) of the previous example. Total P_S is reduced from .94 to 0.91 despite the last system is half as good.

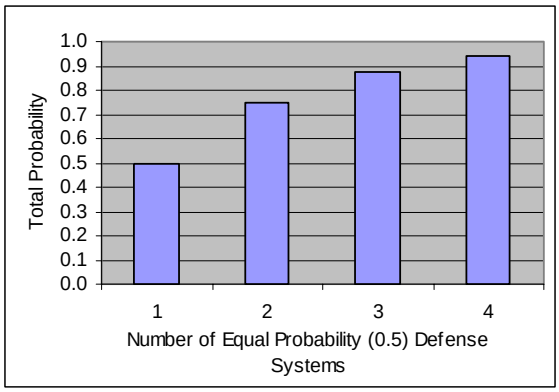

Figure 1: Total Probability for Layered Defense with Equal Probabilities

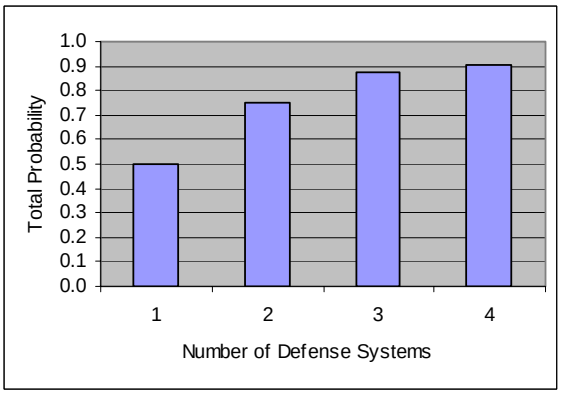

Figure 2: Total Probability for Layered Defense where fourth layer is 0.25

Additional systems no matter how effective only marginally increase P_S. This exercise furthermore highlights that no one system will every be 100% accurate, that a layered system will never achieve 100% success and that each additional layer regardless of cost or complexity only adds marginally to the overall effectiveness of the system.

Relying on P_S is a tenuous route. Suppose you have a new system that could properly identify enemy aircraft 100% of the time, but identified friendlies or neutrals only 98% of the time. The following table compares its performance in low and high intensity environments each with 100 targets. The circles identify the total targets that appear as hostile (positives and false positives) and might be engaged without intervention.[xxi]

	Low Intensity		High Intensity	
	99 Friendly/CIV	1 Enemy	60 Friendly/CIV	40 Enemy
Correct ID	97	1	59	40
Incorrect	2	0	1	0

Table 1: Low vs. High Intensity Probability Comparison

In the low intensity environment, the system incorrectly identified 2 of 3 (66% of the assumed enemy aircraft). In the high intensity conflict it was wrong just 3%. This obviously presents a command and control dilemma for the commander, especially in a littoral conflict where there could be a preponderance of civilian/friendly aircraft.

Performance data should be suspect. The preceding example is a purely hypothetical demonstration of the application of statistics in modeling system defenses. Consider first that most performance data comes from the manufactures tests under the most controlled circumstances. Even tests by the services are under ideal circumstances. A CBS *60 Minutes* show highlighted the poor performance of the Patriot system, accounting for four of 44 successful intercepts during Desert Storm. Over 10 years later, system kill performance improved destroying 12 of 12 targets; however three (25%) were actually friendlies.[xxii]

Salvo equations have been used for well over 100 years to quantify gun fire exchange between ships to determine force dispositions. Hughes' Missile Equations are adapted for modern missile and Carrier warfare and shed light on the balance between striking power and staying power and the variables which affect the engagement outcome. In his equation (Appendix Figure 4) striking power of the attacker is countered by defensive power. The difference (what gets through the defenses) is divided by staying power. If the attacker's punch is equivalent to two kills and the defender is able to reduce it by one, the staying power must be greater than one otherwise the ship is out of action.

The Salvo equation can be modified for a swarm or raid tactic by adding multiple attackers, B, and defenses, A. It becomes intuitively obvious that as long as staying power is less than or equal to one the ship will be OOA. Staying power is as important as striking power.[xxiii] Swarm tactics particularly perplex planners because defenses may be saturated. If each unit in a swarm has the striking power equal to the staying power of the ship, the

defense must be perfect. If staying power is increased above one hit, then an imperfect defense can sustain a missed attack.

THE VALUE OF STAYING POWER

Staying power is directly proportional to the magnitude and type of weapon. It is not constant. The staying power of a ship versus a .50 caliber machine gun might be quite high. However, against an Exocet missile it may be one or less. What is luminary about Hughes' equations is that staying power is independent. It is the only element of the equation that is not modified or reduced by another factor, such as targeting effectiveness. Staying power is always on watch, doesn't 'break', requires no spare parts nor training and does not know the fog of war. However, in current ship designs, staying power is a critical vulnerability because it is less than one for ordnance of just modest size.

For a case study, the USS PRINCETON (CG 59) and the USS TRIPOLI (LPH 10) both hit a mine on 18 February 1991 in the Persian Gulf. PRINCETON received extensive damage, disabling the 5" gun, aft vertical launch system (VLS) and propulsion system. She was dead in the water and had to be towed for repairs. PRINCETON was OOA and a mission kill. In this case her staying power versus that mine was less than one.[xxiv]
USS TRIPOLI hit a mine and sustained damage (Appendix Figure 5). She resumed her mission within hours, later entering port for repairs. Although the physical construction of the ships were similar, TRIPOLI's staying power was much greater than one in this example due to her immense size and capacity to absorb the blast and the shock. The location of the explosion was also fortunate in that it was not near a vital area.[xxv]

Staying power has a larger upfront construction cost and a long term cost in additional fuel. However, it doesn't have the long term costs associated with traditional defense systems: maintenance, manning, legacy part support, etc.

CURRENT STAYING POWER INITIATIVES

Until recently ship construction techniques, plank on frame, haven't changed since wooden ships. Steel has enabled stronger and larger ships, but advances in steel strength have gone to weight and ownership cost savings, not staying power. [xxvi] This stronger, thinner steel has even lead to a term called "hungry horse" (Appendix Figure 7) where the hull deforms around the frames due to stresses (which incidentally increase radar reflectivity).[xxvii] The U.S. Navy is investigating transformational hull designs in three major areas: molded composite materials which will allow radically different hull forms; stainless steel double hulls; and a hybrid composite and stainless steel construction. Another initiative is "explosive resistant coatings to with stand shock and ballistic assault."[xxviii]

An all composite hull is limited to smaller ships (<200') due to longitudinal stresses. The hybrid solves the size limit problem of an all composite hull. Both have less intrinsic staying power, but weight savings could be used to add additional protection. Although the double hull does provide additional staying power, the driving factors in all the research is "stealth, lower total ownership cost, and weight reduction."[xxix]

The Office of Naval Research web site lists 12 Future Naval Capabilities (FNC). Under "Fleet/Force Protection" the third priority is: "Ability to resist and control damage from weapons while preserving operational capability," mentioning double hulls as a milestone.[xxx] According to an engineer at the Office of Naval Research, double hull has been withdrawn as an official FNC and future construction is in doubt.[xxxi]

RECOMMENDATIONS

The American culture is to fix problems. This translates to our approach to military weapons development: identify a threat and counter it. This is a threat based strategy—"how do I defend against a mine." What is required is a goal based strategy, which starts

with "how do I prevent mine damage." Every stakeholder in the Sea Base planning process should list their first requirement as sufficient staying power to sustain a single attack without mission kill. Current initiatives in hull design are at a pivotal junction where radical changes to the near future Sea Base are being made. The U.S. Navy's tradition was born in fast ships going in harm's way. But speed in NCW is relative to that of electrons not hulls. High level leadership must make conscience decisions to use economies gained from advanced hull construction to pay for staying power investment directly mitigating combat damage risk.

Human nature is innately optimistic. Our presumed technological and training supremacy can lead to over-reliance which can lead to overconfidence.[xxxii] No technology or amount of knowledge dominance will ever peer into another person's head. Force planners should be realistic in their expectations of NCW and save optimism for leadership.

Sea Base and Sea Shield planners must include the reality that coastal traffic, neutral shipping and air contacts will traverse the Sea Base area. Exclusion Zones amount to warning areas and do not relieve a commander from the responsibility to determine HI/HA.

Staying power has an inherent deterrence effect. Had there been significantly less damage to USS COLE due solely to staying power, the perpetrators may consider that such a hard target was not worth attacking again. It is the author's opinion that the extensive damage, loss of life and public outcry resulting from the attack encourages future attacks.

CONCLUSIONS

Sea basing is a future joint capability which reduces overall vulnerability. However, the sea has unique weaknesses due to those inherent in the sea and to its location in coastal or international waters. These are vulnerabilities which increase the risk to effective combat power. Conserving the force's fighting potential is achieved through "maximizing survivability by minimizing susceptibility and vulnerability."[xxxiii] Although the goal of the

NPS study was to compare force mix against platform and NCW, the first conclusion from the study was "survivability was determined to be the primary measure of effectiveness of force protection."[xxxiv] Additional survivability needs to be built into the assets as more combat power is concentrated in the Sea Base and as a potential enemy's tactical success can have strategic implications. A single hit not only has the potential to be a probable mission kill, but may have significant political effect and deny access or question Sea Shield effectiveness.

Protecting LOCs will likely be an operational objective and international law demands it. Although the risk to the Sea Base remains constant during MOOTW, civilian traffic should have a feeling of normalcy. Operating with friendlies and neutrals is not new to naval warfare; however planners and operational commanders must not fully rely on automatic processing systems to correctly detect every target. Hence, there must be an assumption that "one will get through." Without the minimal staying power advocated by this paper, the Operational Commander will not be able to fully protect combat power and the people who execute it.

Staying power in warships has become a pejorative term conjuring up visions of battleships laden with heavy armor and torpedo belts on the hull. This type of staying power was essential in the large caliber gun age prior to missiles and fire control radar. Staying power today, as promoted by this paper, is a design where a vessel does not have to withstand a barrage attack, but one where it must not succumb to a mission kill after a single missed point attack. Mines and torpedoes cause grave concern due to their potency and below the water line effects. The defensive system's effectiveness is irrelevant after a successful attack. If staying power is greater than one, the ship will still be combat effective

regardless of whether P_S was 0.5 or 0.99. Staying power adds a foundation of risk tolerance upon which other defensive systems can be built.

An extraordinary amount of research is spent trying to out guess our potential adversaries and catalogue every conceivable weapon and delivery platform and then to determine a counter against either the weapon or the delivery. Network Centric Warfare tied to an ever complex intelligence collection and dissemination system proposes to increase the awareness of the commander to defeat the attack before it happens. In the now famous words of Secretary of Defense Rumsfeld, "There are also unknown unknowns–the ones we don't know we don't know."[xxxv] The commander will never know everything and the enemy will always be resourceful in exploiting deception and gaining the element of surprise operating within our OODA loop; at some point the enemy will be successful.

USS CONSTITUTION gained its famous nick name "Old Ironsides" because cannon shot appeared to just bounce off her hull during battle. This was no accident. Resource rich America had abundance off old growth live oak trees no longer found in the Old World. Shipwrights were able to reinforce frames and planking, in some places three layers deep. Framing was as close as 1 ¼" compared to a foot or more in contemporary frigates.[xxxvi] So when hit by cannon it was more likely that the shot would hit upon a reinforced area than thin planking found in other traditionally built ships.[xxxvii]

Today, the United States is still resource rich in financial and technological means. The United States has always valued "life over machines" and equipped its military with the best technology has to offer. As the Sea Base concentrates the people and equipment which will sustain combat operations in a hostile environment, the vessels which protect them from the ravages of the sea should also have the intrinsic staying power against attack. Staying power does not have the same ostentatious glamour as a sophisticated weapon system

although now its technology may be just as advanced. Staying power will show the strength of US might when the next sailor exclaims, "Huzzah, her sides are made of iron!"

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APPENDIX

Figure 3: Determining Probabilities

Mathematically, it is easier to determine the opposite: the probability that the missile will get through. Therefore:

$P_{missile} = 1- P_{Success} = 1- P_{S1} * 1- P_{S2} = 1-0.5 * 1-0.5 = .25$

The probability of successfully engaging the missile is $P_S = 1 – P_m = 1 - 0.25 = 0.75$

With the additional system $P_S = 1-[1-0.5 * 1-0.5 * 1-.5] = .875$

Figure 4: Hughes Salvo Equations

Out of Action	OOA	
Staying Power:	α_1	
Striking Power:	b_2	
Defensive Power:	α_3	
Targeting Effectiveness	σ_B	$0 > \sigma > 1$
Defensive Readiness	τ_A	$0 > \tau > 1$
Number of Attackers	B	
Number of Defenders	A	

$$\Delta A_{OOA} = \frac{\sigma_B b_2 B - \tau_A \alpha_3 A}{\alpha_1}$$

Figure 5: USS Tripoli Mine Damage [xxxviii]

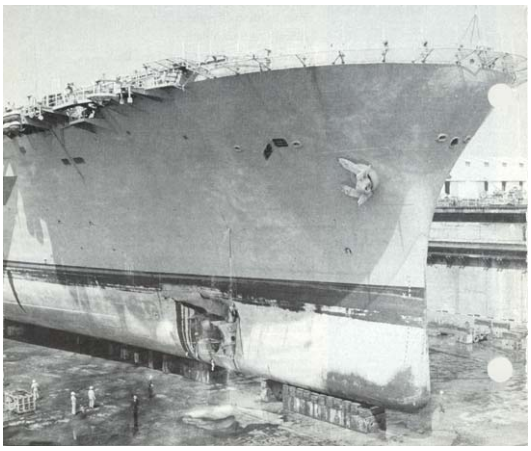

Figure 6: USS COLE damage [xxxix]

Figure 7: Hungry Horse [xl]

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